Silvopasturing in the Northeast

An Introduction to Opportunities and Strategies for Integrating Livestock in Private Woodlands

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Overview

Silvopasturing is the deliberate integration of livestock and timber production, which provides new agricultural opportunities with unique applications and efficiencies. Current social, market and ecological factors have increased the suitability for many rural landowners to adopt silvopasturing systems. University, private, state and federal organizations and agencies have resources to assist new silvopasture practitioners

Silvopasturing is relatively new in the Northeast as a deliberate and recognized land use. Silvopasture practitioners, or “silvograziers”, may arrive from a starting point with small or large-scale traditional livestock production, woodland management, or other agricultural interests. This guide is designed to help prospective silvograziers develop an understanding of the issues and opportunities associated with silvopasture systems in the Northeast. The guide will not provide all answers, in part because considerable research remains to address questions such as forage development in shade, forest regeneration systems for silvopastures, and the general performance of combined timber and livestock production systems. As silvopasture systems gain in popularity, new strategies and solutions will emerge.

This hand book was written to inspire others to gain experience with silvopasturing and to help them jump ahead on the learning curve. Our collective knowledge building and sharing of these experiences will strengthen our success with silvopasturing in the Northeast and give us another valuable tool for the management of rural land.

Silvopasturing is the deliberate and managed production of livestock and timber or other forest products on the same land over an extended period of time

Introduction

Silvopasturing is an agroforestry system used to produce both livestock and forest products on the same land over an extended period of time. It can be thought of as a hybrid between well-managed pastures and well-managed woodlands. The term implies skilled management, beneficial outcomes, deliberate attention to multiple objectives, and symbiosis between grazing animals and their wooded environment. A silvopasture can be developed from one of two perspectives: enriching open pastures with trees, or modifying natural forests and plantations through thinning to develop forage plants in the understory. But regardless of the origin, silvopasturing requires careful attention to the production of sufficient quality forage, to sound livestock husbandry, and to sustainable woodland practices – and also to the practitioner's goals.

Though the practice of silvopasturing is relatively common in some regions of the world, the inclusion of livestock in forested ecosystems has generally been discouraged in the Northeast over the last half century due to past conservation issues. Historically, the introduction of livestock into woodlands lacked the characteristics of silvopasturing that ensure its sustainability. The relationship of prescribed burning to wildlife is a useful analogy to the relationship between silvopasturing and uncontrolled woodland grazing. Further, modern-day challenges such as the control of undesirable vegetation, and viable production from an ever-shrinking agricultural land base are factors that encourage us to reconsider silvopasturing as an ecologically and economically-sound practice for some land on some farm operations in the Northeast.

The successful integration of pastures and woods – that is, grazing with silviculture - requires an experienced eye and knowledge of both disciplines.

Practitioners of silvopasturing, silvograziers, use varied and creative strategies to accomplish their production goals. Silvopastural systems can work with a variety of livestock in a variety of woodlands. Relatively small operations can attain efficiencies of scale, and silvopastural methods can be integrated within other existing farm and woodland production systems.

Current Circumstances that Justify the Expansion of Silvopasturing

<u>Compatible with the northeastern landscape</u> – The typical northeastern farm contains open land juxtaposed with wooded areas. Wooded areas are often treated as a separate and marginally useful portion of the farm, which has often led to their neglect or mismanagement. Silvopasturing is an opportunity to integrate some wooded areas with the overall farm operation, resulting in more benefits for the farmer and creating greater incentive for good stewardship through more deliberate and efficient land use.

Increased demand for local food production and niche livestock products – "Grass-fed", "free-range", "naturally-raised" and other specialized livestock products are niche opportunities in the rapidly growing market for local foods. The expansion of silvopasture-based production can help meet this demand and complement traditional agriculture. Furthermore, some specialty products like "acorn-finished pork", gourmet cheeses, or chevron (goat meat) are ideally produced in silvopastures. Non-livestock food products like maple syrup, nuts, fruits and mushrooms can also be produced from silvopastures, as well as valuable timber.

Left: *this planted silvopasture of black locust and black walnuts yielded $1500/acre of quality locust fence posts from the first thinning at 20 years of age. The land continues to grow valuable timber and livestock products*

Challenge to grow more food without more land – The world population is expected to increase 50% by 2050, while at the same time other factors like biofuels production, land conversion, new demands on traditional crops, and soil fertility loss will further strain food production from a limited arable land base. Silvopasturing is an opportunity to grow both livestock products and forest products from the same land, while at the same time preserving the important environmental and socio-economic benefits of forestlands.

Farm viability – Increasing land ownership and business costs are a constant challenge for farmers. These challenges require farmers to optimize efficiency to get the most from their land without compromising its future productivity. Silvopasturing provides opportunities to generate new and more frequent incomes from wooded portions of the farm, while at the same time realizing other benefits discussed in the following section.

Modern technology and production systems – Innovations in fencing and equipment have lead to increased experience and expertise with "management-intensive grazing", which is an essential part of good silvopasture management. These same innovations,

such as high-tensile fencing and wide-impedance fence chargers, are ideal for silvopasture environments.

Emergence of woody biomass markets to feasibly harvest low-grade timber – It is now possible to sell low-quality trees in many areas of the Northeast for pulp, firewood and chips. This has created opportunities to commercially thin cull trees from native stands and plantations to stimulate understory vegetation and promote the growth of the best remaining trees. A commercial biofuel harvest also reduces the amount of debris left in the understory which could impede livestock movement and shelter the growth of invasive plants.

Restoration of degraded forestland and control of interfering plant species – Studies in New York reveal that upwards of 80% of private forestland has been managed in the absence of guiding silvicultural principals, often leading to significant losses timber productivity over the life of the stand. In many situations, the prevalence of invasive and interfering plant species across the forest landscape is an exponentially growing problem that reduces land value and productivity, diminishes habitat quality for wildlife, and disrupts normal ecological succession and forest stand dynamics. Silvopasturing can be an effective and feasible tool to counteract and rehabilitate areas impacted by "too much of the wrong plants."

Silvopasturing may seem unorthodox, but it is not unlike managing a woods as a sugarbush

Benefits of Silvopastures

While the rewards of silvopasturing are as numerous as its many forms of implementation, the following are some major benefits:

Increased stocking capacity of farm – The profitability of livestock operations depends in large part on their ability to take advantage of resources and operate efficiently. Silvopasturing is an opportunity for graziers to utilize, when appropriate, the woodland resources of their farms. This increases the productive base of the existing farm and helps amortize fixed operation costs with more total production and greater gross income. Expansion of grazing into wooded areas can also improve cash flow by augmenting the periodic income of timber sales with the annual income of livestock products.

Cost-effective vegetation control – As noted in the previous section, invasive (non-native) plants as well as native plants that are out of balance with the ecosystem (i.e., "interfering plants"), and are a widespread problem in the Northeast with significant economic and ecological consequences. There is often a high opportunity cost of "doing nothing" to address these issues, especially for the individual landowner. Mechanical and chemical controls are usually costly and are generally only a superficial and short-term solution for a situation that will recur if not addressed at its root cause. The intentional and consistent use of livestock to reduce and manage problematic plants at an acceptable level provides short-term income opportunities and long-term land stewardship.

Above left: *these cows are comfortable in their "living barn" during harsh winter weather. This spruce plantation provides a self-cleaning and appreciating shelter for out-wintered livestock.*

Above right*: these goats will gleefully "work for food" to clear noxious vegetation, while at the same time produce valuable meat.*

Improved animal performance through greater comfort – Grazing animals will generally perform better if sheltered from extreme heat and cold. Silvopastures provide shaded grazing in the summer, which can lead to increased grazing time, greater forage intake, and possibly higher average daily gains. In the winter, these same silvopastures can

ameliorate the stress of wind chill and radiant cooling (direct exposure to cold, clear skies) which helps the animals to maintain body condition and potentially saves in feed costs. Silvopastures may also provide relatively clean, comfortable, damage-resistant loafing areas during thaw periods as animals lie and stand on mats of dropped leaves reinforced from below with sod and tree roots. However, care should be taken to avoid excess and repeated damage to tree roots, especially in shallow-rooted species like maple. The symptoms and consequences of excessive tree root damage are often insidious and may not be apparent for a period of years or to the inexperienced observer.

Improved animal health through better diets – Livestock with access to a complete mineral supplement generally do better than those with just plain white salt. The same holds true for forage. Silvopastures can diversify animal diets by providing access to a variety of plants that may not be found in open pastures. These plants, in turn, can provide beneficial plant compounds that enhance animal performance and health. More research is needed in the areas of forage sequencing, sensory feedback, micro-nutrition, the antiparasitic properties of some plant compounds and other understudied aspects of animal health and nutrition as it relates to silvopastures. But limited research and anecdotal experience suggest that greater diet diversity result in healthier animals. More research is also needed to compare the relative nutritional values of common forages from silvopastures and open pastures over the growing season. Initial research done by the USDA's Agricultural Research Service in Beaver, West Virginia reveal that some cool season grasses grown in the light shade of silvopastures have higher nutritional content and greater palatability than those growing in full sunlight.

Balancing of seasonal forage curves – Pastures in the Northeast consist primarily of cool-season forages that decline in growth and nutrition during the hot summer months. This seasonal decline typically coincides with the period of greatest nutritional need for lactating animals. Silvopastures can compensate by providing a greater variety of quality forage and a microclimate that is more favorable to cool-season plant growth during mid-summer. The foliage of hardwood trees can also serve as an emergency food source during extreme drought. The value of these emergency reserves should be taken into account during thinning operations. An example is to leave excess aspen trees when not directly competing with high-value "crop trees". A large aspen tree may provide about as much quality food for hungry livestock as a round bale of hay.

Creation of High-Value Wildlife Habitat – Whereas some wildlife species are strictly forest- or grasslands-dwelling, the majority utilize "edge" habitat between open and wooded areas. Silvopastures can be thought of as extensive edge habitats that provide wildlife with both food and shelter. Savannah ecosystems in other regions of the world are generally considered to be some of the most biologically diverse habitats in terms of wildlife. Historic accounts reveal that native Americans maintained substantial portions of today's agrarian landscape in relatively open, savannah-like forests – presumably to attract and hold wild game. Those same conditions are also attractive to livestock.

Left: *Black Angus cow-calf pairs grazing in lush silvopastures in late-July. The diverse and abundant mix of vegetation beneath the tree canopy provides excellent grazing conditions during mid-summer conditions when the cool season forages in open pastures are largely dormant.*

Other significant benefits from silvopasturing include the creation of diversified income sources, enhanced protection of riparian grazing areas, the creation of an aesthetically pleasing landscape, and possible qualification for tax abatement programs.

Requirements for Functional Silvopastures

Not all woodlots are suitable for silvopasturing, but many farms have wooded acreage that can be developed into quality silvopastures to help meet landowner goals. The following checklist should be addressed when assessing the suitability of a parcel for silvopasturing:

Access – Isolated silvopastures will generate higher costs for transporting materials and livestock, and for maintaining and managing the system. If livestock is hauled vs. driven to the silvopasture, will a low-clearance stock trailer be able to reach the pasture?

Terrain – Can the area be enclosed with a secure fence at a reasonable cost to keep livestock in and predators out? How difficult will it be to periodically inspect the perimeter fence?

Water – Is there a sufficient, clean and reliable water source on the site, or one that can be developed at a reasonable cost? Can water be delivered to each silvopasture paddock in a cost-effective and reliable fashion to properly rotate and rest each paddock?

Husbandry – Is the operator willing and able to care for livestock and all that comes with it? Does the operator understand the inherent differences between and within breeds, including nutritional needs and behavior?

Site Productivity – Is the site capable of growing enough good quality forage and timber to provide an acceptable return on time and resources invested in the silvopasture?

Site Sensitivity – are the soils prone to drought, water logging or erosion? Are there special and unique habitats on the site that should be protected, such as vernal pools?

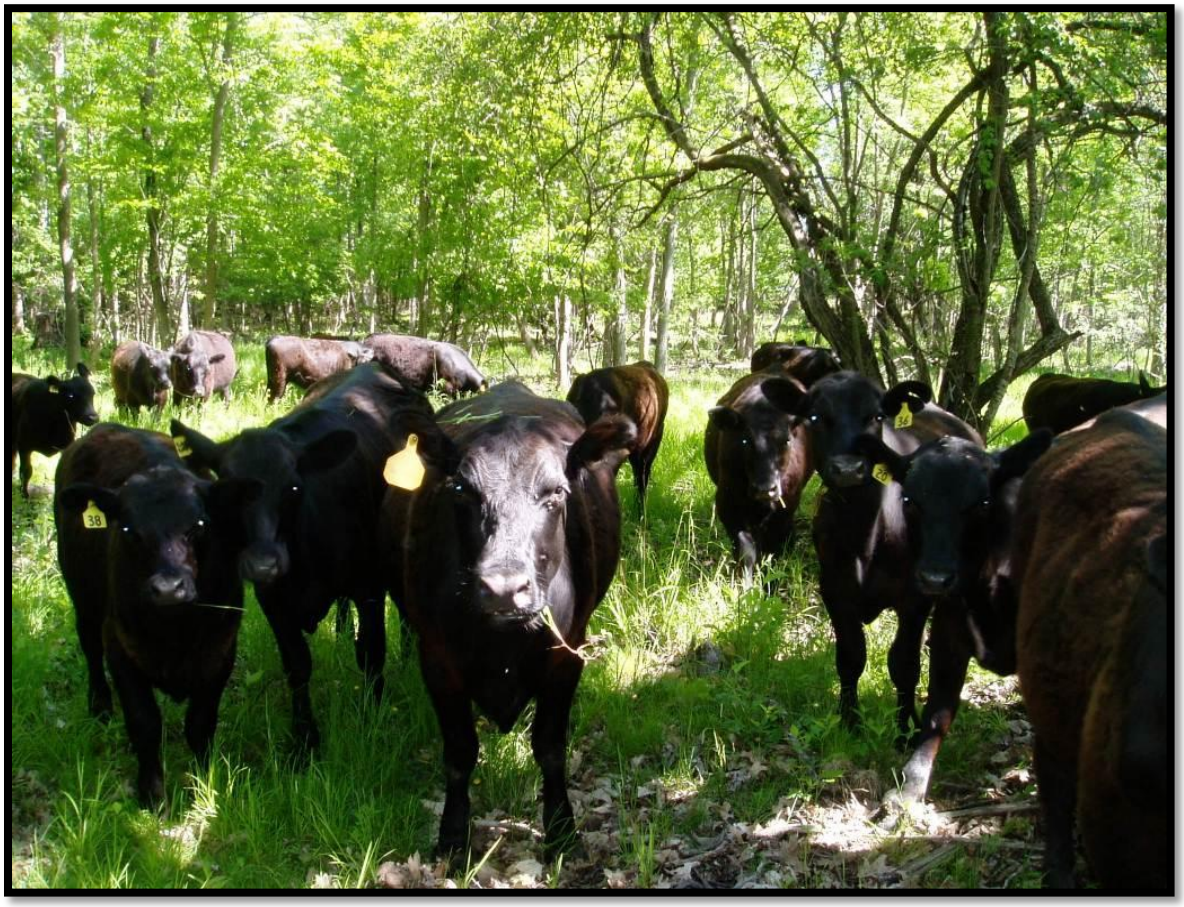
Acreage – is the area large enough to support a feasible operation? Can adjacent areas be developed that will provide room for expansion?

Keys to Establish and Maintain Forage Plants in the Silvopasture

Adequate Sunlight at Ground Level – Stand density and structure must be modified to allow adequate sunlight to reach the ground level in a "three-dimensional" pasture system. A "stand" is the wooded acreage and equivalent to a farmer's "field." Stand density refers to the number of trees, and in this context whether the canopy of trees is closed or allows sunlight to the ground. Structure here refers to the proportion of small versus large trees, and more generally describes the physical appearance of the forest cover. Adjusting sunlight requires skillful thinning of the timber component with consideration for the quality, value, health, spacing, crown-class (vertical position of the crown in the forest strata), live-crown ratio (depth of crown compared to total height of tree), crown density and species of each residual tree. Methods and considerations for thinning forest stands are discussed in a following section.

Satisfy the Establishment Requirements of Target Forage Species – Whether the forage base is predominantly woody or herbaceous, nearly all plant seeds require direct contact with mineral soil to germinate and become established. Consequently, some type of intentional mechanical disturbance to the duff layer of forest soils is necessary to create a suitable seedbed. Some practical methods for exposing mineral soil include intense livestock trampling (or rooting, in the case of pigs), or timber harvesting in the absence of snow cover. Mechanical dragging may also be practical in plantations. In the case of artificial seeding, a broadcasting seeding onto a properly prepared site, followed by intense livestock trampling should yield the best results if timed to coincide with periods of adequate moisture. Once desired plants are established, silvograziers should monitor the abundance of other plant species to ensure they don't interfere with successful development of browse and forage. Additional soil characteristics such as proper pH, adequate sunlight, and timely moisture will also aid forage establishment. Winter yarding (hay feeding) in developing silvopastures may also help establish

vegetation due to nutrient and organic matter deposition, as well as the soil disturbance caused by concentrated animal movement.



Above: *a heavy understory of shade tolerant invasive plants was removed and the overstory canopy thinned to allow volunteer forage plants to become established just months after increasing sunlight at the ground level. A wild apple tree can be seen behind the cows, which was left to produce soft mast.*

Sufficient Rest Periods – The frequency, duration and timing of livestock grazing in a pressure on desirable plants. A short, intensive grazing period followed by a longer rest period is likely to produce better results over time than the converse. Understory plants in a silvopasture receive less exposure to sunlight than plants in an open pasture, and therefore require more time to replenish their energy reserves. Likewise, most woody shrubs, seedlings and saplings will be more sensitive to the frequency, intensity and timing of defoliation than herbaceous plants. As a general rule, desirable woody plants should not be browsed more than twice when foliage is present, although plant tolerance to browsing will depend on other factors such as species, growing site, exposure to sunlight and the amount of defoliation that occurs with each grazing. To

the extent possible, desirable woody plants should not be browsed during periods of peak vulnerability (post leaf-out in the spring, and prior to leaf-drop in the fall). Livestock should be excluded from newly-seeded or regenerated areas until fully established, unless selected trees are protected with some type of shelter.

Desirable Qualities of Food Sources in a Silvopasture

Silvopastures can provide a variety of food sources for livestock, such as:

Forages – Broad-leaf herbaceous plants, grasses, sedges

Browse - The edible portions of woody plants

Mast - Fruits, nuts, pods, seeds

Other – Roots, bulbs, tubers, fungi, insects, and invertebrates (especially for pigs and poultry)

Of these, browse and forages are the most common and reliable food sources for grazing animals. Ideally, good forage or browse is:

- Perennial in growth to reduce re-establishment costs
- Persistent enough to compete with other vegetation and withstand grazing
- Palatable and nutritious enough to meet animals' needs over an extended season
- Cheap and easy to establish without expensive inputs
- Shade tolerant enough to grow in reduced light levels

Left: *a cow enjoys lush locust sprouts in mid-summer. The foliage from these sprouts compare favorably to other high-quality forages. Coppice growth (stump sprouts) and suckers (root sprouts) can be retained as a valuable food component in the understory through management.*

Left: pigs enjoy acorns produced by large oak trees growing in silvopastures. Soft mast such as these acorns can be a valuable finishing feed for niche livestock products like free-range pork

Creation of the proper conditions for plant establishment and growth will often lead to the development of sufficient levels of volunteer vegetation over a period of years in a silvopasture. However, in some cases, it may be cost-effective and desirable to augment naturally-occurring vegetation with artificial seeding. The US Forest Service Northern Research Station has done some initial research on shade tolerance of common perennial forages for northern climates. Species that show promise are: Reed

Canary Grass, Bluegrass, Eastern Gama Grass, Tall Fescue, and Orchardgrass, and Kura Clover. However, not all of these forages would be practical to establish or manage in a silvopasture system. More research is needed to identify and evaluate the performance of both herbaceous and woody plants in silvopasture conditions, as well as establishment techniques.

Left: *creating the proper conditions through management will usually result in the development of a stable and desirable vegetative understory over time through volunteer plant establishment and growth. This is a gradual process that requires patience, monitoring and the continual management of the livestock and timber components of the silvopasture*

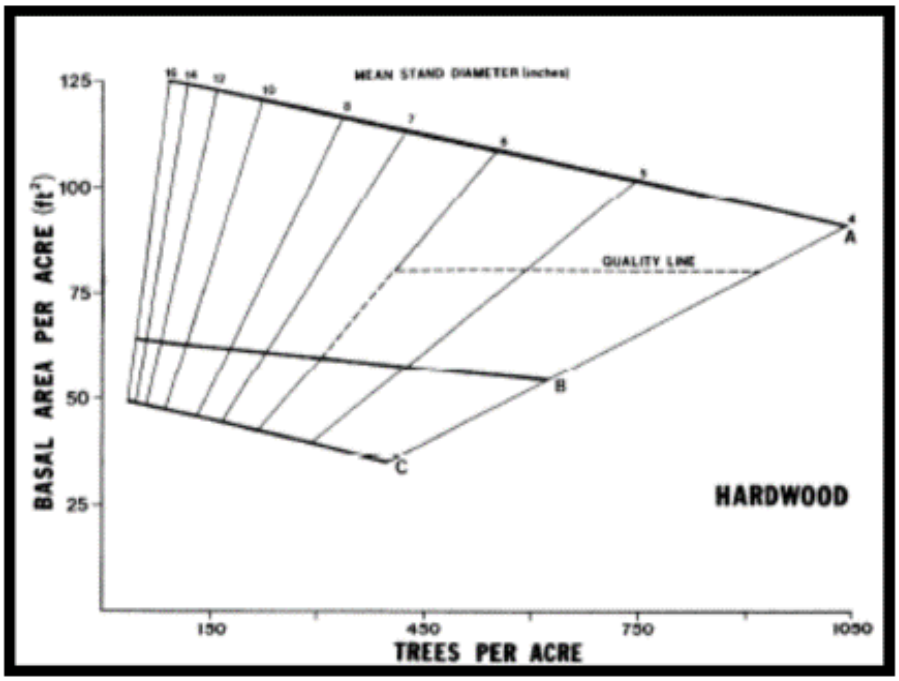
Thinning Woodlots and Plantations to Create Silvopastures

Insufficient sunlight at the ground level means insufficient vegetation for livestock to eat. Thinning wooded areas to adequately open the forest canopy - that is, to reduce tree stocking levels - is the single most important factor to develop and sustain a productive silvopasture. Stocking of trees is comparable to stocking of animals and relates to the abundance per acre relative to the amount of resources available for growth.

Thinning a forest stand attempts to reduce the stocking from a higher level to a lower level. Foresters have developed charts to guide the intensity of thinning to optimize production of timber. Silvograziers must reduce the stocking of their woodland to lower stocking levels to ensure better forage and browse development. Stocking charts have thresholds of tree density defined as the A-, B- and C-lines of stocking relative to timber production (see Figure 1). Forest stands with basal area per acre and trees per acre at or above the A-line are considered overstocked and too dense for good growth of trees in the main canopy. The “B” line is defined as the target post-thinning stocking to maximize timber production. The “C” line is the point at which a stand is insufficiently stocked for optimal timber production and significant gaps in the upper canopy exist. While these increased sunlight levels may boost vegetative growth in the understory, timber production is less than optimal. Stocking, a readily measurable indicator of forest density, is normally measured in terms of “basal area.” Basal area is the surface area of tree trunks measured at 4.5 feet above the ground, and can be easily measured

using a variety of instruments such as angle gauges, prisms, fixed plot measurements, and even a calibrated thumb.

Most unthinned timber stands contain over 100 square-feet of basal area per acre. Good development and growth of many quality food species requires a reduction to about 60 square-feet of basal area per acre. This stocking level would generally fall between the “B” and “C” lines of a stocking chart. Fortunately, stocking levels can be maintained on most silvopastures that balance both good forage and timber production. However, more research is needed to develop silvicultural prescriptions that optimize food and timber production for silvopastures of a given stand composition and growing site.



Above. Figure 1. *An example of a stocking chart for a hardwood stand that can be used to guide thinning intensity for timber stands of an average diameter. For most sites, acceptable understory growth will appear at around the B-Line (~ 60 ft^2/acre of basal area). Thinning below the C-Line will compromise future timber production on a per acre basis. Adapted from Leak et al. 1967. Silvicultural Guide for Northern Hardwood Types in the Northeast (revised). USDA Forest Service, Northeastern Forest Experiment Station, Research Paper NE-603.*

Reaching proper stocking levels for optimum food and timber production is usually not possible through a single thinning without suffering unintended negative consequences like “thinning shock” to residual trees, windthrow, epicormic branching, and possibly a proliferation of unwanted vegetation in the understory. Less intensive thinning treatments that spread out the stocking reduction over a period of years will generally give better results by allowing both understory vegetation and residual trees to gradually adjust to increased sunlight. Synchronizing livestock grazing capacity with thinning

operations is the best way to minimize an excessive proliferation of problematic vegetation in the understory.

Thinning operations are usually classified as “commercial” (harvested trees sold for a profit), or “pre-commercial” (trees culled at a cost although the owner may utilize the wood). Silvograziers can use different strategies at different spatial scales and in different parts of their woods to accomplish commercial or pre-commercial operations. Owners should avoid the temptation to exploit the current commercial value of their woodlands by prematurely harvesting sawtimber. Sawtimber exploitation is called “high-grading” where the best trees are cut and the lower quality trees remain. Livestock herds and woodlots both respond in the same negative manner to reverse culling, but the consequences of a high-grade harvest last for many decades. From the standpoint of long-term forest productivity, health and profitability, it is best to nurture the superior trees by removing inferior trees that directly compete with them – much the same as weeding and thinning a garden. This form of management is often referred to as “crop tree management” because thinning decisions are intentionally focused to benefit the best “crop” trees in the stand. However, in a silvopasture, additional trees that do not directly compete with crop trees - but which intercept sunlight - may also need to be thinned in order to allow enough sunlight to reach the ground level of the silvopasture.

In addition to reaching proper stocking levels by leaving good quality crop trees, there are other important aspects to choosing which trees to leave and which trees to cull during thinning. Some species like hemlock, beech and spruce have dense crowns and foliage that will shade understory vegetation more than light density crowns like aspen, larch and black locust. Canopy height, the relative spacing between trees, and the depth and diameter of tree crowns in the main canopy will also impact the levels of sunlight that reach the ground.

Tree root systems and root system products will also affect the establishment and persistence of understory vegetation. Examples of root interactions with understory plants include potentially allelopathic (suppressant) chemicals like Juglone from walnuts, or beneficial compounds like available nitrogen from leguminous trees like black locust. Competition for growing space, moisture and nutrients from tree roots will also affect understory plant growth.

Other examples of how tree species will affect understory development include the decomposition rate of foliage (fast vs. slow), the average leaf-out date (early vs. late), and the impact of foliage on pH. The foliage from oaks, for example, will break down more slowly on the forest floor and potentially create a mulching effect than the foliage from black locust, which breaks down quickly. Likewise, locust usually breaks bud an average of two weeks later than many native hardwood trees, which helps to boost spring growth. Some trees, like conifers, may gradually acidify the soil surface over time. More research is needed to understand the relative impacts of different tree species on forage plants in the understory.

Left: *an example of the influence of tree species on understory vegetation. Grasses and sedges can be seen growing in the background beneath maples, but are absent in the foreground beneath a large hemlock, despite filtered sunlight reaching both locations. Some trees have very dense and superficial root systems, or roots that exude compounds that suppress competing plant growth. Despite their antagonistic effect on understory forage growth, it may be desirable to retain some of these species in selected locations of silvopastures for other objectives like biodiversity, wildlife habitat, or as thermal cover for animals*

Complex thinning decisions can be eased by employing the help of trained professionals. Foresters are an invaluable resource to inform landowner decisions and effectively execute management plans. Most foresters will not be familiar with the concepts of grazing and livestock management, but they are experts in vegetation management. Care should be taken to choose a forester who is willing to work towards and interested in the silvograzier's goals. Some of the important expertise and services that foresters can provide are: tree selection for thinning operations; contract administration and supervision of harvests; identification of special resource concerns; sale of timber or contracting of work through a competitive bid process; tax planning for timber income; development of a (silvopasture) management plan; assistance with securing funding through grants and conservation programs; and the development of prescriptions and methods that are most likely to achieve management goals.

Foresters can be a valuable resource to implement silvopasture development and should be utilized for significant timber harvests

When possible, a commercial thinning should be used to accomplish thinning objectives for the following reasons: the time-intensive, equipment-intensive and hazardous work is performed by qualified contractors; the work can be accomplished at a gross-profit and in a relatively short period of time; and the harvest of merchantable trees often results in less obstructive debris in the understory. Examples of products that may be sold in a commercial sale include sawtimber, pulp wood, firewood and chips for biomass applications.

Pre-commercial thinning may be necessary when the culled timber is of insufficient value or volume to attract a buyer, but is often a prudent investment that will yield good dividends in terms of future timber growth and livestock production. Some practical and cost-effective methods for culling low-value trees in a pre-commercial sale include:

Felling – Trees are cut down and then left on-site to either provide wildlife habitat and enrich the soil, or can be harvested and processed for firewood, fence posts, lumber or mushroom bolts.

Girdling – A chemical or mechanical tool is used to sever the cambium layer (conductive tissue directly beneath the bark) and the tree is left to die in place. Chemical treatments legal in woodlands vary based on state pesticide laws, but include basal treatments (a penetrating herbicide applied on the surface of the bark at the base of the tree such as Garlon 4), or frill treatments (shallow, downward angling cuts that are filled with herbicide). For mechanical girdling, a fully-connecting cut should be made about one inch below the surface of the bark (less for small-diameter trees). Cutting too deeply will increase the chance of trees snapping off. A double-girdle will increase the probability of completely severing the cambium. Girdled trees can often be salvaged for a number of years for firewood, but extreme care should be taken when felling trees with dead limbs. If left in place, they will provide valuable wildlife habitat known as "snags" and slowly decompose in a manner that does not obstruct the understory. Trees should not be girdled near stationary targets such as corrals, buildings, or other damageable infrastructure. Different species will die at different rates after being girdled, and some species such as pines, maples, beech and aspen may take several years or more to completely die.

Poisoning – Some herbicides can be injected, or sprayed into girdle or frill cuts on the main stem. Some herbicides can even be applied to the surface of the bark. Systemic herbicides such as glyphosate can also be applied to fresh stump surfaces to prevent coppicing (stump sprouts) or suckering (root sprouts). Herbicides should be applied in accordance to the label.

Flame Weeding – An organic method of girdling trees and shrubs when managers choose not to girdle with chemical or mechanical tools. Heat from a torch-like device is used to kill the cambium layer. Detailed recommendations for herbicide and flame thinnings can be found under the "publications" section of www.ForestConnect.info

Above left: *a hemlock tree that was killed using the mechanical girdling method. Two connecting girdle cuts were made just below the bark, and the tree was left to die in place creating a valuable wildlife snag as it slowly decomposes in place.*
Above right: *a group of large buckthorn trees that were poisoned using glyphosate sprayed into frill cuts at the base of the trees. The rapid volunteer response of cool season grasses beneath the dead trees occurred just one season after treatment. If these trees had been cut, the resulting debris would have obstructed the ability of livestock to graze the site and control invasive re-growth.*

Mowing – There are a variety of heavy-duty machines designed for mowing brush and small trees in forest settings. These mowing machines, - especially the smaller, more agile versions such as the "Timber Ax" - may provide cost-effective and lower-disturbance alternatives to bulldozing or excavating. Another advantage is that mowed trees and brush are in large part chipped and left on-site without creating debris barriers in the understory. Coppice growth from mowed hardwood stumps tends to be less vigorous, perhaps due to the shattering effect on stumps. But mowing may aggravate the proliferation of other species such as beech, privet, and multiflora rose.

Livestock - The destructive actions of livestock (trampling, defoliation, bark stripping, rooting) are usually not sufficient to accomplish the thinning objectives unless combined with other methods listed above. But some livestock can be intensively managed to purposefully root up, girdle or push over smaller trees and brush. Intensive livestock browsing can also be used as a follow-up control for undesirable sprouting that may occur after felling, flaming or mowing.

Above: " *The right tool for the right job". Livestock, such as this highland cow, may be an effective way to control some vegetation by trampling young trees and brush, but larger and more rigid brush and trees may require additional mechanical methods such as a mowing machine designed for forest conditions.*

Below: *Goats were intensively managed ("mob grazed") in small paddocks using portable electrified net fence to heavily defoliate and girdle an undesirable understory of hop hornbeam, beech and striped maple saplings in this sugarbush.*

Methods to Establish Trees

The previous section discusses methods to thin an existing stand of trees to reduce stocking in order to stimulate understory growth. However, the goal may also be to establishing new trees in open pastures, or understocked silvopastures where younger age classes are needed for eventual recruitment into the overstory as crop trees. New trees can be established through artificial methods such as planting and direct seeding,

or by natural regeneration and sprouts. Success in either endeavor requires skill, attention to details, planning, and a bit of luck.

Most tree seedlings and sapling will need protection until they are several inches in diameter at the base and firmly above the browsing height of livestock and deer. Smaller trees will be susceptible to rubbing, stripping of bark, and bending that will limit their survival, health, and value for sawtimber.

Planted trees need to be protected from browsing, defoliation and girdling by livestock, wildlife and insects. Tree shelters, such as a mesh or corrugated plastic tube, may help promote tree growth and protect young trees from pests like field mice and rabbits. But due to the propensity of livestock to rub, ram, root up and chew on objects of curiosity like a tree shelter, an additional more formidable barrier may also be necessary, such as a woven field wire ring or barb wire. When possible, tree shelters can also be placed around seedlings that are developing inside of logging slash that is obstructive enough to discourage livestock. Planted seedlings should also be freed to the extent possible from competition for sunlight and rooting space by mulching, weeding or applying herbicides. A detailed guide to tree planting can be found under the "publications" section of www.ForestConnect.info

Establishing new trees through natural regeneration can be even more challenging than planting. Professional assistance from a forester will increase chances for success. Intentional establishment of regeneration requires carefully timed thinning, followed by an eventual full or partial removal of overstory trees to release advanced regeneration. The removal of overstory trees can be done across an entire stand, across silvopasture paddocks, or in patches just large enough to allow sufficient sunlight to reach small groups of saplings. Shade tolerant species like American beech and sugar maple can survive in lower levels of sunlight than shade intolerant species such as oak, cherry, poplar, and hickory. As with planted trees, regeneration must be protected from livestock and deer until it is tall and sturdy enough to resist browsing damage to the terminal growth points. Considerations for the natural regeneration of forest trees, though not including silvopastural issues, can be found in the publications section of www.ForestConnect.info

Piling the tops of harvested trees in areas of adequate sunlight is one practical method to shelter young regeneration. The tops will provide protection for a few years if livestock is not pushed to seek out the more difficult to reach young trees that are sheltered in the piles. After a few years, most tree tops will have decayed to the point where they no longer provide adequate protection. Other structures may be necessary to protect seedlings until they achieve sufficient size.

Strategies to regenerate trees in a silvopasture can utilize different spatial and temporal clustering of seedlings. These strategies are provided as a general guideline and can

be used together, singly, or with modifications on a property. Tree establishment can be artificial or natural, as explained above.

Single continuous recruitment establishes and protects a few trees every year beneath small openings in the upper canopy. Trees can be planted, or selected from desirable natural regeneration. Seedlings will need to have individual and robust protection. This strategy is appropriate for silvograziers who favor small-scale management and harvesting of individual trees.

Small patch recruitment clusters trees in ¼ to ¾ acre patches. A patch can be established on regular time intervals that allows for full regeneration of a property over a specific length of time, depending on the area of the woodland. For example, a 20 acre woodland might be fully regenerated over a 40 year period by regenerating four ¼ acre patches every 4 years (two acres total every four years). Each patch can be fenced-in with deer netting or another effective barrier to protect seedlings as they develop into saplings. This strategy will favor silvograziers who have the skill and equipment to manage the volume of trees removed in each patch.

Stand-wide recruitment will set aside an entire stand (or paddock) and treat the whole stand at once. The stand would be excluded from grazing until there is adequate stocking of desired tree seedlings and saplings that have reached an appropriate size. The entire stand will need to be protected from grazing. As the seedlings develop, light and infrequent grazing may provide some beneficial thinning of dense seedling understories and reduce the need for subsequent thinning. More research and experience is needed to determine the feasibility and impacts of grazing in regenerating stands. This strategy would favor silvograziers who have enough acreage to continue grazing other paddocks while the regenerating areas are closed to livestock for a period of years.

Left: *the successful establishment of natural regeneration is rarely a one-step process. Adequate desirable regeneration must be developed in the understory over a series of thinning treatments, followed by the removal of most overstory trees to avoid suppressing the young trees. These silvicultural systems for encouraging the establishment of natural regeneration are known as "seed tree" or "shelterwood" methods.*

Benefits of Growing Good Trees in a Silvopasture

Good forest management can be summarized as “growing the best and cutting the rest”, and the same can be said for trees in a silvopasture. Leaving the best “crop” trees to grow increases the probability that they are appreciating in value, are more vigorous and more resistant to insect and disease threats, are longer-lived, and will produce more seed and mast. Some specific benefits of growing trees in pastured areas include:

Diversified Products – Quality trees can be harvested at financial maturity for premium prices, in accordance with the management plan. They can also yield products like fruits, nuts, lumber, firewood and fence posts for sale or for personal use.

Shelter – Comfortable animals perform better. Trees can shelter livestock from weather extremes, provide tax-free “living barns” that appreciate in value, and reduce forage quality losses from frost and heat.

Wildlife Habitat – Silvopastures provide favorable habitat for many wildlife species, comparable to “edge” habitat that meets two key needs: food and shelter. Simple steps can be taken to further enhance habitat quality such as retention of den trees, downed trees, snags and high-quality mast trees.

Soil Building – The combination of trees with forages maximizes both the fungal and bacterial activity in the soil. Tree foliage contributes large amounts of organic matter to the soil surface, and tree roots can generally pull nutrients up from deeper soil profiles than herbaceous plants.

Nutrition – Most tree foliage is palatable and nutritious throughout the growing season, and can provide an emergency food source during mid-summer droughts. In addition to foliage, buds and soft twigs, trees can also provide supplemental nutrition through the production of mast. The mast of some species like oaks, apples, hickories, honey locust and cherries can provide excellent finishing for specialty products like free-range pork.

Aesthetics – Open wooded areas with grazing livestock beneath are a rare sight today in the northeast, despite their historical prevalence. Attractive agrarian landscapes such as silvopastures can increase property values, and also public perception and support for farming and forestry.

Protecting Crop Trees

A justified concern for pasturing livestock in woodlots developed because animals were often given free access to wooded areas for extended periods of time. The resulting

impacts such as soil compaction and damage to the root collars of trees accentuated the spread and growth of root decay fungi. Significant timber defect in the lower and most valuable portion of the tree resulted, as well as damage to forest regeneration needed for the continuity of the stand. Silvopasture management is distinct from these historic (and sometimes on-going) examples of mismanaged woodlands in that the intensity, frequency, timing and duration of livestock grazing in the woods is carefully managed to achieve goals while preserving the long-term health and productivity of the woods. Unregulated grazing is to wildfire as silvopasturing is to prescribed burning – the former can have a harmful impact on woodlands, whereas the later can be a powerful tool for woodland enhancement if done properly.

Points of Caution

Toxic Plants – Sensory feedback and learned grazing behaviors will usually protect livestock from poisoning threats, but care should be taken to limit exposure to serious threats like yew, mountain laurel and the wilted foliage from Prunus spp. (cherries, peaches, plums, almonds). Many plants contain potentially toxic compounds that can harm livestock if consumed in excessive amounts. But good herd management practices like gradually exposing livestock to unfamiliar plants, frequent rotation, constant access to good food sources, and frequent inspection of livestock for problems will minimize the risks associated with toxic plants. Lists of potentially toxic plants are available from your Cooperative Extension educator or on the internet.

Predators – Silvopastures can be an attractive environment for predators as well as livestock. A well-electrified, secure perimeter fence is the best protection against predators. Other strategies for coping with predators include: the use of guard animals; bringing animals into secure areas at night; mixing large animals with small ones (cows and horses with sheep and goats); and birthing later in the spring when alternative food sources are available for predators.

Parasites – The diverse, compound-rich plant diets and favorable microclimates provided by silvopastures may help livestock better resist some common parasites such as biting flies and barber-pole worm. On the other hand, it may increase exposure to others such as *Paralaphostrongylus tenuis* ("deer worm"), and ticks. However, these parasites are manageable with sound herd management practices. Frequent movement of the herd to clean ground reduces the incidence of parasites in grazing livestock.

Rabies – This disease is endemic in many areas of the Northeast, and livestock exposure to rabid animals is potentially higher in silvopastures. Proper vaccination can minimize this threat.

Hazards – Care should be taken to minimize sharp objects and other hazards in silvopastures such as old dumps and wire, pointed stumps and sharp limbs near the

ground, and particularly hazardous trees - all of which can cause serious injury to livestock.

Hunters – The presence of livestock will be less apparent to hunters in a silvopasture than in open areas, so either move animals to safer locations during peak deer hunting season, or properly sign the perimeter. Work with hunters to restrict access to those who are willing to take adequate care to protect your livestock. Some graziers may choose to limit deer hunting to archers.

Invasive Plants – The same conditions that promote the growth of desirable plants will also favor aggressive undesirable plants. Balancing silvopasture development with animal stocking rates will help manage some of the less-palatable species like thorny plants or those with a bitter taste. But toxic or very unpalatable species like may apple and privet may need supplemental control such as herbicides, burning, intensive soil disturbance or repeated mowing. Different plants may require different and integrated tactics, so know the foe and hit them where it hurts. See the vegetation management section in the publications at www.ForestConnect.info

Left: *Nature quickly acts to fill voids. In this picture, an invasive overstory of European buckthorn was mowed only to see a proliferation of Mayapple (Podophyllum sp.), which are not palatable to livestock. Herbicides or intensive livestock impacts are now needed to reduce the may apple to an acceptable level and transition the site to more desirable plants.*

Right: *A heavy invasive understory of shade-tolerant plants was mowed, but Privet (Ligustrum spp.) quickly spread through root and stump sprouts. Privet is resistant to both herbicides and livestock grazing, so a combination of intensive controls, including possible alternative controls such as rooting with pigs may be needed for a period of a few years to sufficiently reduce Privet levels.*

Tips for Success

Planning – Diligent planning will weigh heavily on the success of a silvopasture project. Implementing the project will require long-term commitment, and the changes made upon the land cannot be easily reversed if the course is changed. Consequently, the importance of thinking things through and developing a budget for the project cannot be overstated. Modifications to woodlands and investments in silvopasture development should be deliberate and prudent. As the saying goes: "If it doesn't work on paper, it certainly won't work on the ground."

Fencing – There are several fencing options that can be used in silvopasture applications, but high-tensile fence will resist falling debris the best and be the most cost-effective over time. Wire should not be directly fastened to living trees or it will quickly become overgrown and fixed to the tree. Low-quality trees could be used as living in-line fence posts, but a durable batten board should first be fixed to the tree, and the insulators or staples fixed to the batten. Fence wire will be less visible to wildlife in a silvopasture, so be sure to use strong insulators to resist damage from collisions.

Recovery – Woody food sources require longer rest periods between grazing events than herbaceous plants to remain vigorous and persistent. Spring ephemeral growth can be grazed in April and early May before bud-swell, but a silvopasture paddock should then rest until woody growth hardens off in early summer – unless the goal is to weaken and diminish the amount of woody growth. Likewise, woody plants should not be heavily browsed in the early fall when starting to translocate nutrients back to their root systems.

Rotation – Move animals frequently and meet their nutritional needs to avoid damaging desired trees and forage production potential. Daily shifts will boost the intake of fresh, high-quality food and keep animals eating the intended forages and browse instead of

trampling and girdling young trees. Quick rotations will also reduce the level of defoliation of woody plants, which helps them recover more quickly.

Diversity – Maintaining a broad food base, a species-rich overstory, and the combination of livestock species are examples of diversification that will normally yield better results in a silvopasture. However, the benefits of a more complex and diverse system should be weighed against the costs, especially for multiple livestock species.

Monitoring – A good manager should frequently evaluate the condition of and changes in the numerous components of a silvopasture to determine progress and the effects of management actions. Baseline documentation, detailed record keeping, and the judicious use of standardized testing (soils, forage analysis, etc) are recommended to continually improve and refine one's skill.

Moving Ahead

Most states offer technical, educational and financial assistance to farmers and woodland owners that could assist them with silvopasture implementation. These expert resources include state agency's service forester, Extension educators, and USDA's Natural Resources Conservation Service (NRCS) field staff. Likewise, some regions also have active grazing, livestock and woodland owners associations that can provide peer support and valuable networking opportunities.

Silvopasturing requires the "artful application of science" from the realms of silviculture, grazing, animal husbandry and soil science to achieve the best results. No one silvograzier can be expected to know everything necessary when starting out, but the learning curve can be shortened by consulting others and studying their examples. Most importantly: experiment and start small – but above all, start. The cost of doing nothing will likely outweigh the cost of making some mistakes as one develops personal knowledge, skill and expertise with silvopasturing.